Updated AMSR Soil Moisture Algorithm and Products

Combined NPD and SCA

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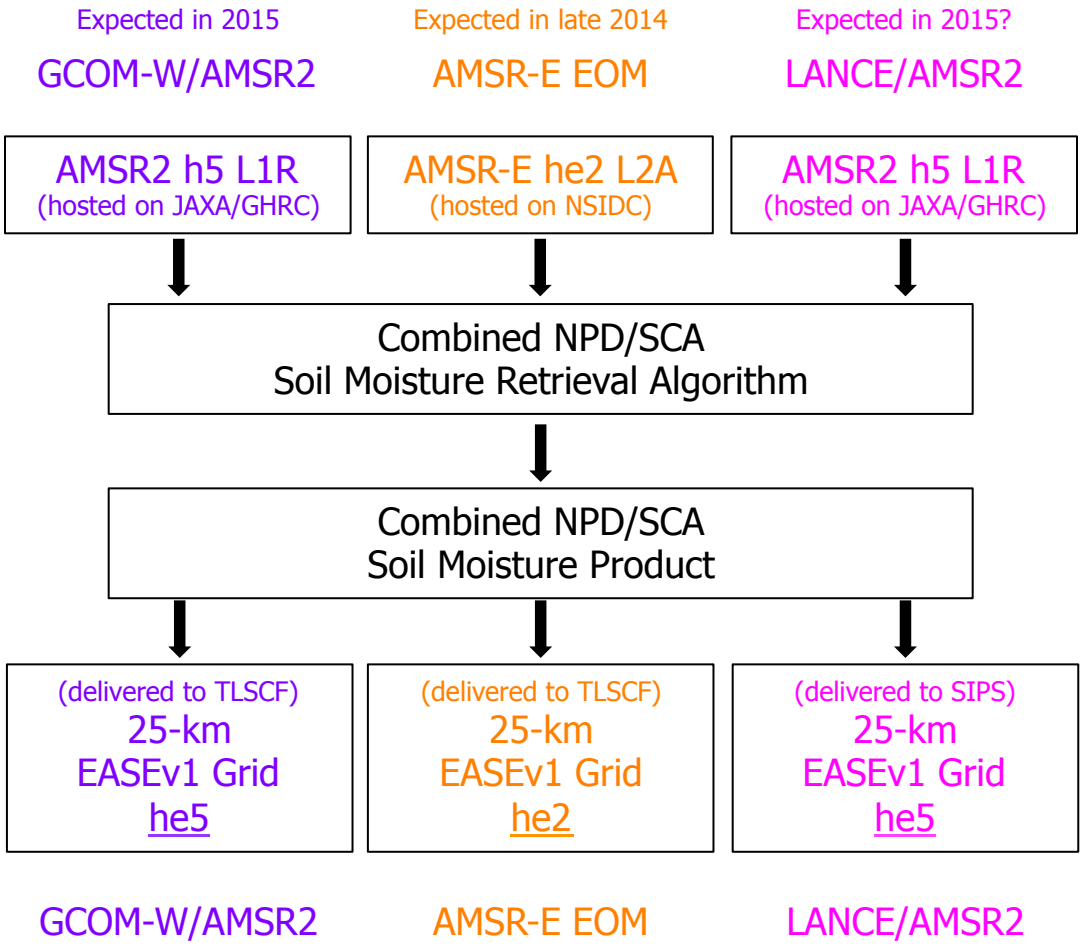
Talk Outline

- Introduction and background - *Njoku*
- Software development of the combined NPD-SCA code - *Chan*
- NPD overview and progress - *Burgin*
- SCA overview and progress - *Mladenova*
- Work going forward - *Njoku*

Introduction

- At last AMSR team meeting the decision was made to combine the two algorithms (NPD and SCA) and provide both soil moisture outputs in the L2 and L3 products
  - NPD = Normalized Polarization Difference, code developed by JPL
  - SCA = Single Channel Algorithm, code developed by USDA/ARS/HRSL
- NPD and SCA codes will be integrated into one software package at JPL and delivered to the TLSCF
- Our understanding is that this will be implemented on operational processors:
  - Aqua/AMSR-E end-of-mission processing – SIPS
  - GCOM-W/AMSR2 processing – SIPS?
  - GCOM-W/AMSR2 LANCE processing – ??

AMSR-E/AMSR2 Parallel Work



Major milestones (AMSR-E Reprocessing)

Stage	Task	Responsible Person(s)	Date
Stage I	Readers: Integrate HDFEOS reader for AMSR-E; HDF5 reader for AMSR2	Chan	June 15
	Ancillary data	Chan/Burgin on data for NPD	
		Bindlish/Mladenova on data for SCA	
	Screening (flags)	Bindlish/Mladenova to report flag counts	
Stage II	Main codes	Chan on NPD codes	Aug 31
		Bindlish on SCA codes	
Stage III	Integrated output	Chan to collect outputs of NPD and SCA	Oct 3*
	Formatting:	Chan to package outputs in HDFEOS or HDF5	
Preliminary Delivery to TLSCF	Complete package for test integration	Chan/Burgin/Bindlish/Mladenova to validate NPD & SCA outputs between SMAP-TB & TLSCF	Oct 10*
Evaluation	Intercompare algorithm outputs for consistency (effort requires 1 month from integrated output readiness)	Burgin/Njoku Bindlish/Mladenova	Oct 26*
Delivery to TLSCF	Complete package for EOM reprocessing	Chan as POC	Oct 31
Stage IV	Comparison, Analysis, Validation	Chan/Burgin/Njoku Bindlish/Mladenova/Jackson	Dec 31
	Documentation to NSIDC	Chan/Burgin/Njoku Bindlish/Mladenova/Jackson	

* Revised from previous

Integrated Software Development

Steven Chan et al.

Combined AMSR Soil Moisture Algorithm

Software Development Environment

To main consistency, both NPD and SCA codes were developed in the same software development environment.

Operating System:

Red Hat Enterprise Linux release 6.2

Fortran complier:

gcc 4.5.2

HDF4/HDFEOS2 libraries:

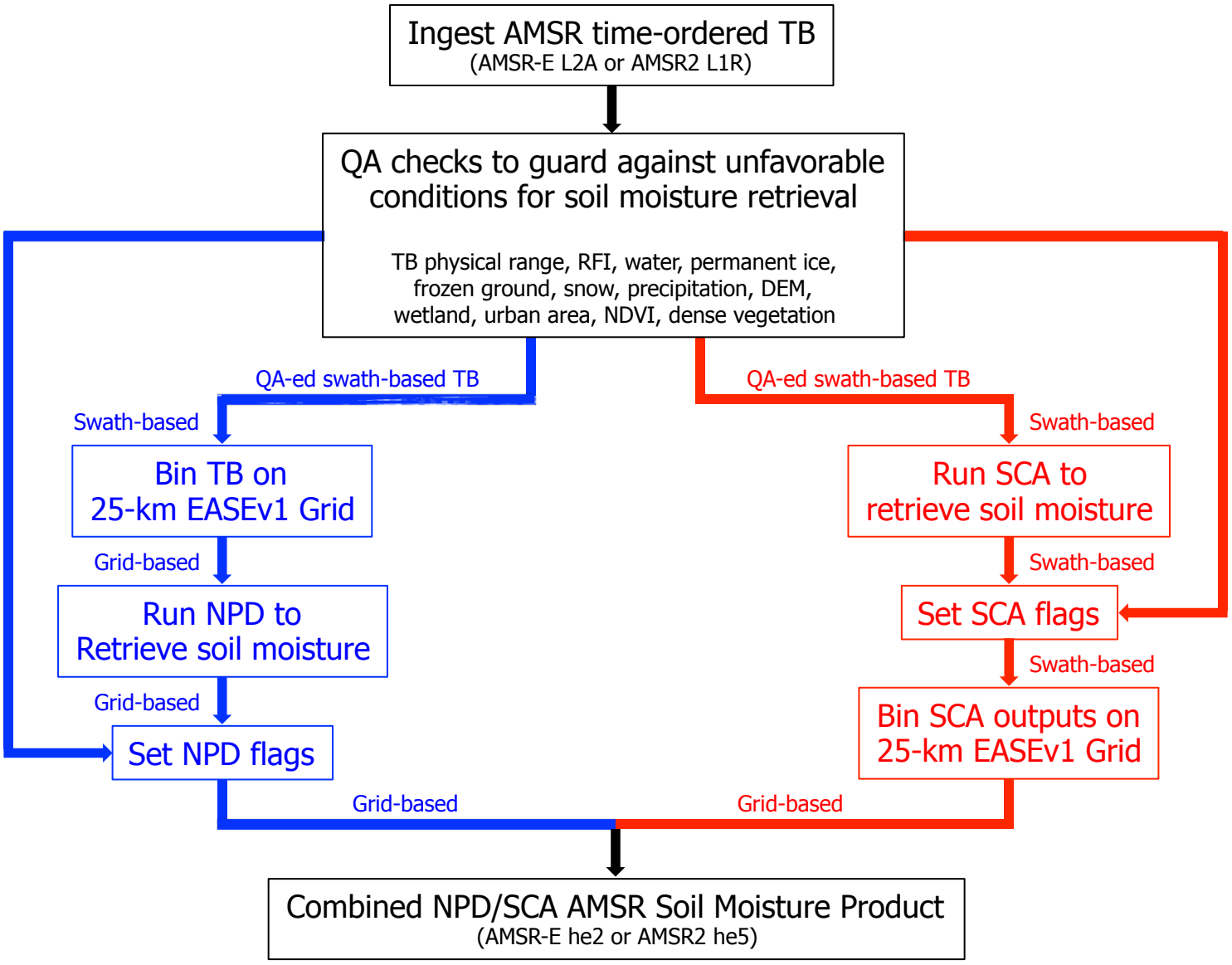
hdf 4.2.6 (built with gcc 4.5.2)
hdfeos 2.18 (built with gcc 4.5.2)

PGE interface to SIPS:

aeland2_main.exe <Input L2A file> <Ancillary Dir> <Output L2B Dir> <PGE version>

Combined AMSR Soil Moisture Algorithm

Flowchart



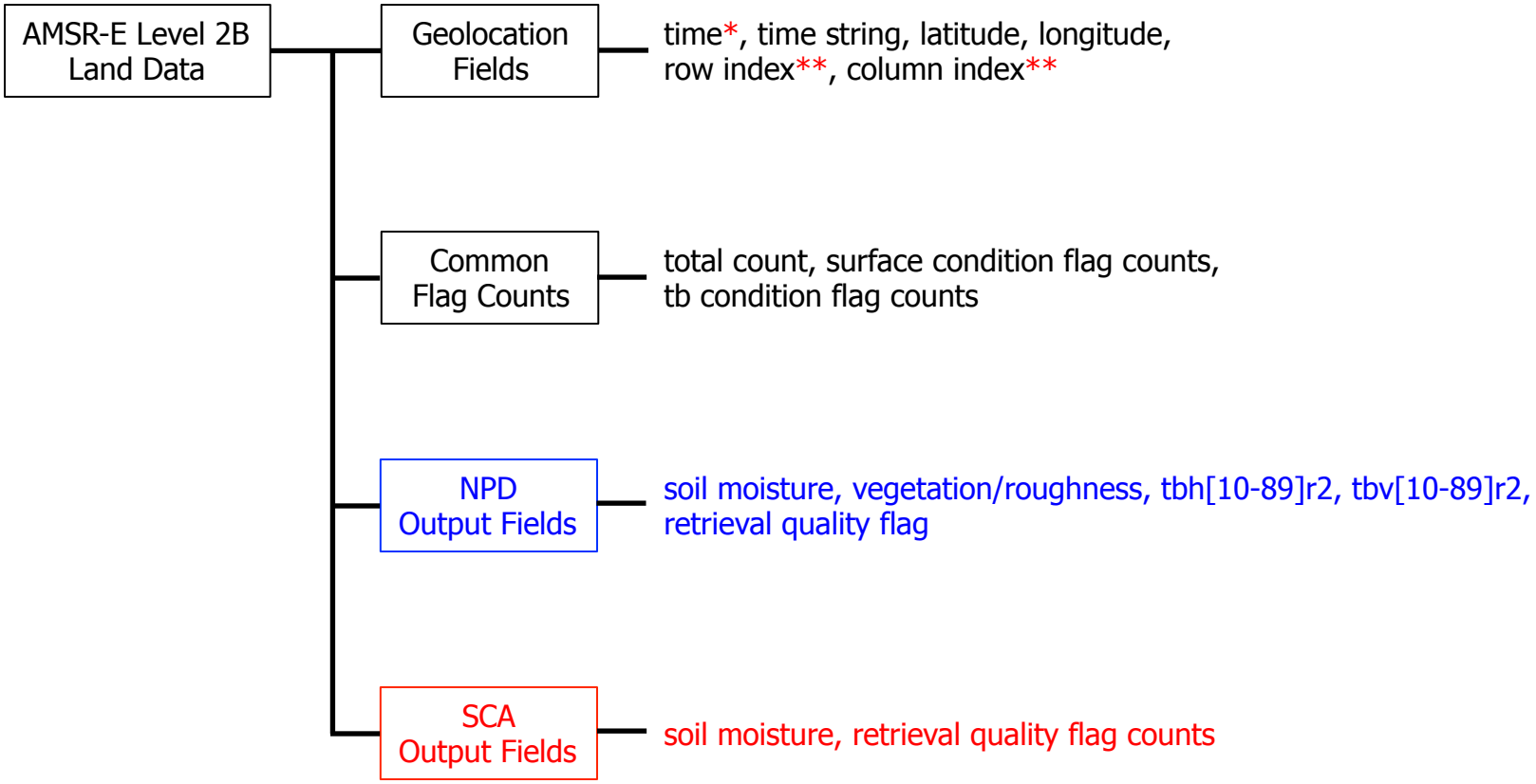
Combined AMSR Soil Moisture Algorithm

Ancillary Data

Ancillary Parameters	Source	Purpose	NPD	SCA
Static water fraction	MODIS	Mask out water where retrieval is not attempted	✔	✔
Land cover classification	MODIS	Mask out wetlands, urban area, and permanent ice where retrieval is not attempted	✔	✔
DEM statistics	GMTED	Mask out mountainous terrain where retrieval is not attempted	✔	✔
NDVI climatology	MODIS	Mask out dense vegetation where retrieval is not attempted	✔	✔
		Provide vegetation correction in soil moisture retrieval		✔
Soil texture	HWSD	Provide input to soil dielectric model		✔
Soil temperature	AMSR TB	Provide surface temperature correction in soil moisture retrieval		✔
Reference NPD	AMSR TB	Provide minimum NPD in soil moisture retrieval	✔	
25-km EASEv1 Grid Latitude/longitude	NSIDC	TB binning using inverse-distance squared weighting	✔	
Minimum soil moisture	Rawls. et al.	Provide soil moisture lower bound as a function of soil texture	✔	
Model coefficients	JPL	Enable global fine tuning of retrieval algorithm	✔	

Combined AMSR Soil Moisture Algorithm

Output Granule Structure



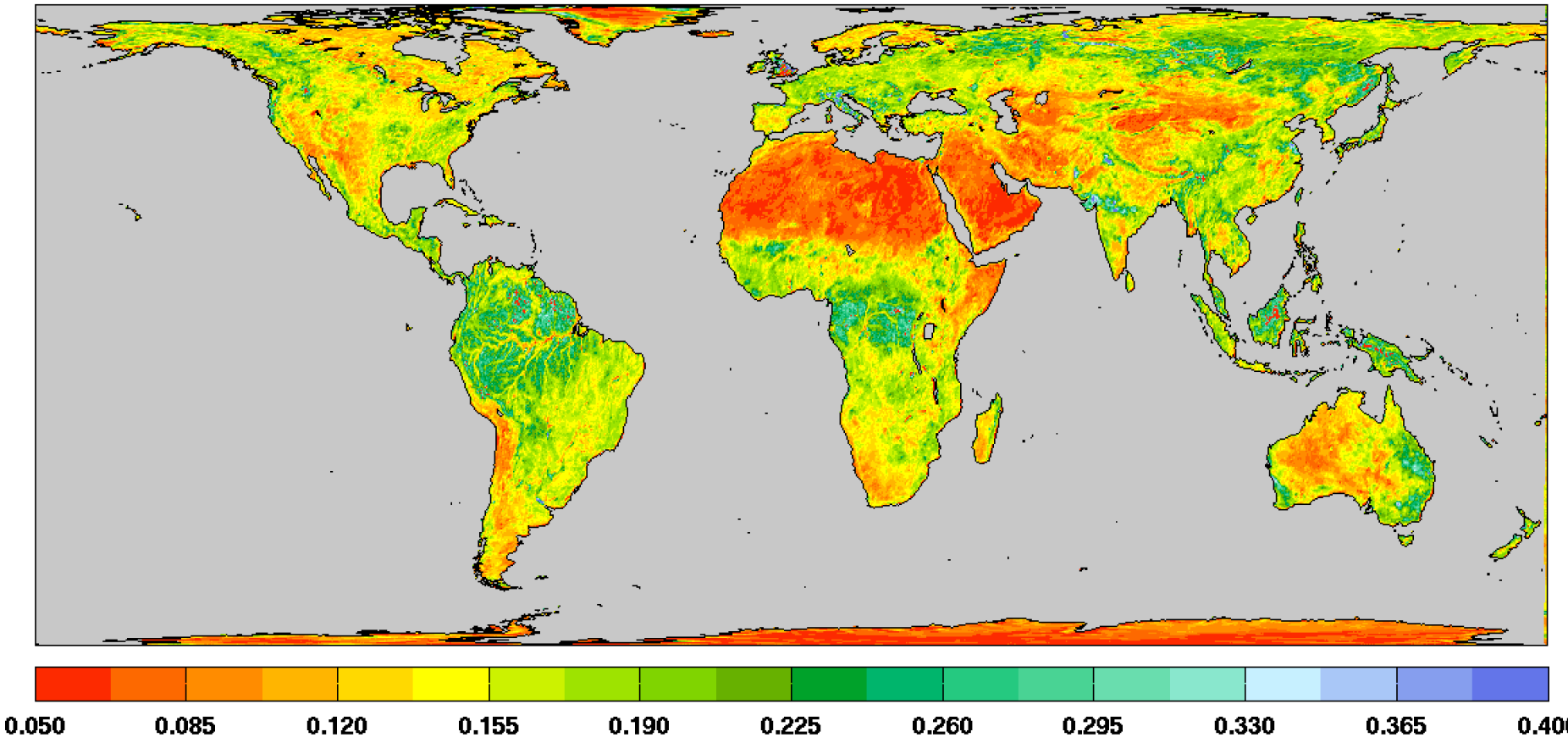
*: TAI93 or J2000?

**: One-based or zero-based?

Combined AMSR Soil Moisture Algorithm

Soil Moisture Retrieval

Preliminary 2007 July 1-3 NPD Soil Moisture Retrieval (before QC mask applied)



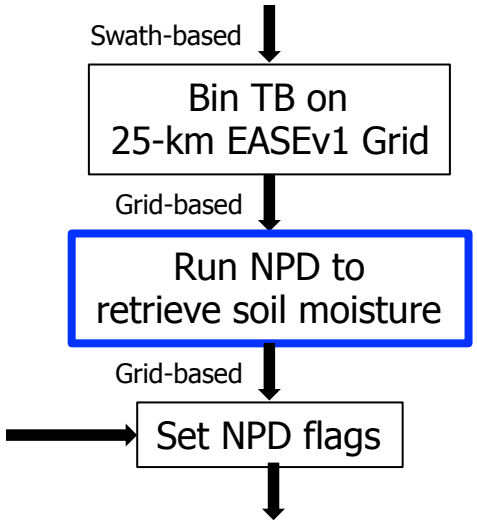
NPD (JPL): Normalized Polarization Difference algorithm

Mariko Burgin, Eni Njoku, Steven Chan

NPD overview

NPD-related binning, ancillary data, NPD coefficients and flags:

- NPD uses Res 2 TB values
- Binning updated from direct mean to inverse distance squared
  - To be consistent with SMAP & NSIDC
- Ancillary data consist of monthly minimum reference NPD (NPD^{dry}) and baseline soil moisture by Rawls et al. (mv^{dry})
- NPD coefficients will be uploaded as five 2-D model coefficient arrays (a_0, a_1, b_0, b_1, b_2)
- Flags updated as previously discussed



The NPD equations

$$mv = mv^{dry} + a_0 * g + a_1 * (NPD - NPD^{dry}) * \exp(a_2 * g)$$

with $mv^{dry} = 5$, $a_0 = 2$, $a_1 = 150$, $a_2 = 0.3$

$$g = b_0 + b_1 * \ln(NPD^{dry})$$

with $b_0 = -3.5845$, $b_1 = -1.6605$

$$NPD = (TB_V - TB_H)/(TB_V + TB_H)$$

NPD^{dry} = monthly 3rd percentile from 2002-2011

The NPD equations

(2) (3)

$$mv = mv^{dry} + a_0 * g + a_1 * (NPD - NPD^{dry}) * \exp(a_2 * g)$$

with $mv^{dry} = 5$, $a_0 = 2$, $a_1 = 150$, $a_2 = 0.3$

(1)

$$g = b_0 + b_1 * \ln(NPD^{dry})$$

with $b_0 = -3.5845$, $b_1 = -1.6605$

(1) Vegetation factor

(2) Baseline soil moisture

(3) Departure from dry condition

Vegetation factor

$$mv = mv^{dry} + a_0 * g + a_1 * (NPD - NPD^{dry}) * \exp(a_2 * g)$$

with $mv^{dry} = 5$, $a_0 = 2$, $a_1 = 150$, $a_2 = 0.3$

(1)

$$g = b_0 + b_1 * \ln(NPD^{dry})$$

with $b_0 = -3.5845$, $b_1 = -1.6605$

- Global comparison of parameter g with Vegetation Water Content (VWC) maps: g ≅ factor*VWC
- VWC is based on Normalized Difference Vegetation Index (NDVI)

Baseline soil moisture

(2)

$$mv = mv^{dry} + a_0 * g + a_1 * (NPD - NPD^{dry}) * \exp(a_2 * g)$$

with $mv^{dry} = 5$, $a_0 = 2$, $a_1 = 150$, $a_2 = 0.3$

$$g = b_0 + b_1 * \ln(NPD^{dry})$$

with $b_0 = -3.5845$, $b_1 = -1.6605$

Re-evaluation of baseline soil moisture:

- Replacing globally fixed value with global map of mv^{dry} (by Rawls et al.)
- Assessment of second parameter by investigating global soil moisture retrieval maps and comparing against in-situ soil moisture records at core validation sites

Departure from dry condition

(3)

$$mv = mv^{dry} + a_0 * g + a_1 * (NPD - NPD^{dry}) * \exp(a_2 * g)$$

with $mv^{dry} = 5$, $a_0 = 2$, $a_1 = 150$, $a_2 = 0.3$

$$g = b_0 + b_1 * \ln(NPD^{dry})$$

with $b_0 = -3.5845$, $b_1 = -1.6605$

- Analysis of global retrieved soil moisture maps
- Validation of retrieved soil moisture maps with in-situ soil moisture

NPD update summary

- Overall NPD equation will remain the same

- NPD TB input updated from Res 1 to Res 2
- Binning updated from direct mean to inverse square distance
- NPD model coefficients updated from scalar to 2-D values
- Update of NPD model coefficients in process

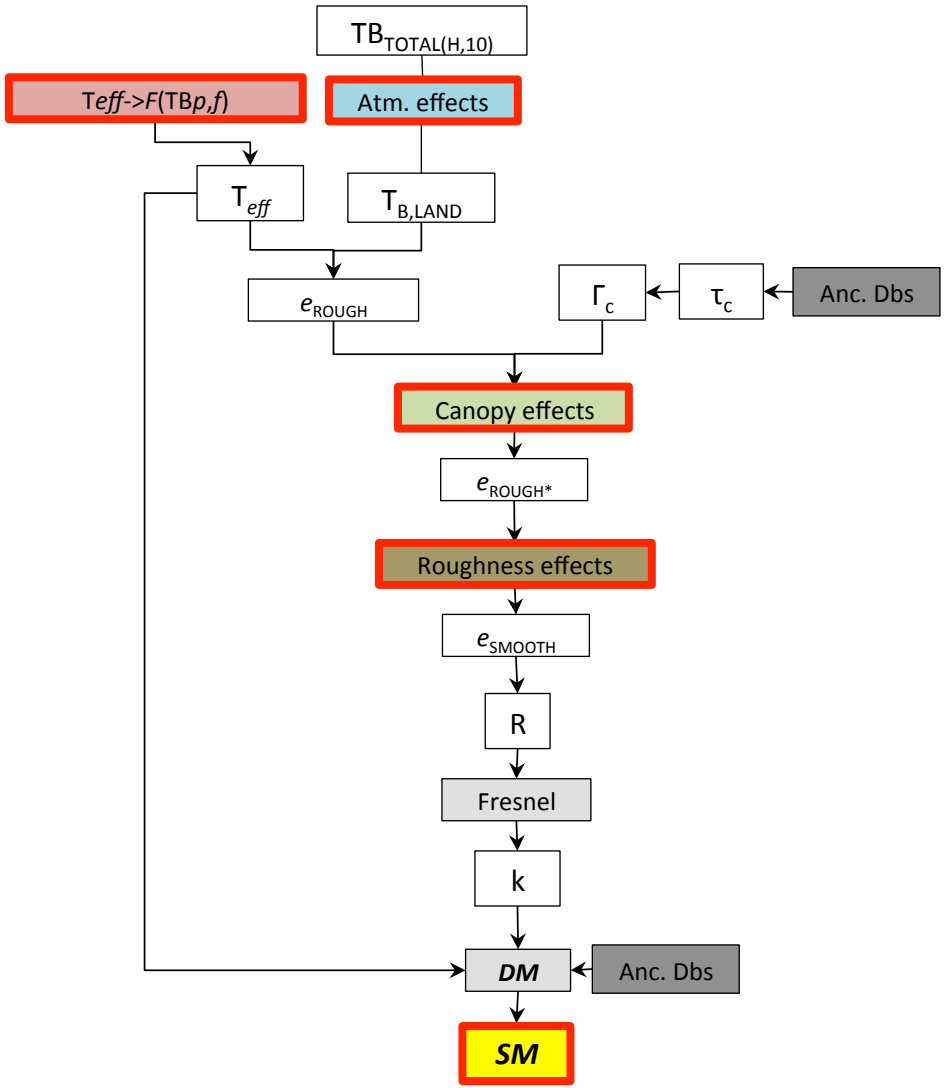
SCA (USDA): Single Channel Algorithm

Iliana Mladenova, Rajat Bindlish, Tom Jackson

SCA: Overview and Progress

- RTE based
  - L2A TB (swath)
- Ancillary datasets
  - Soil Properties
    - HWSD (FAO)
  - NDVI
    - MODIS (AVHRR)
  - Land cover
    - MODIS(Landsat)
    - Annual maps (Climatology)
  - Updated approach

  for estimating VWC.

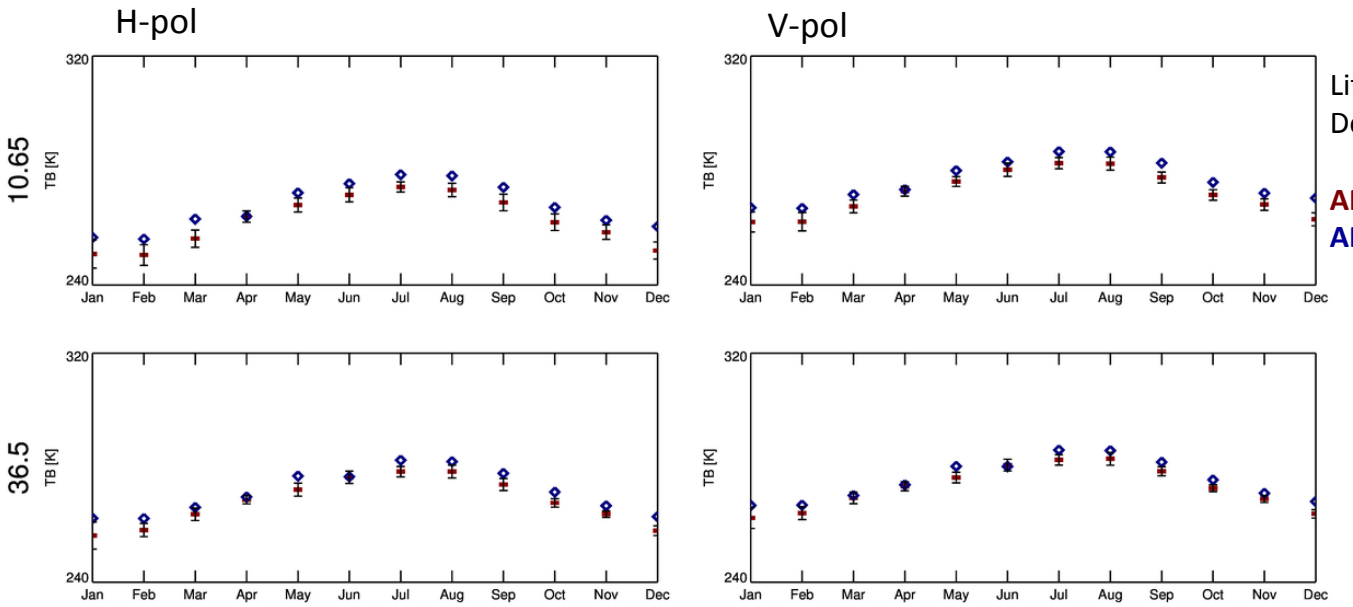


SCA: Transferability to AMSR2

- Theoretically SCA can be applied directly and without modifications to AMSR2 given that AMSR-E and AMSR2 TB are consistent.
- Conducted an inter-comparison analysis to establish the consistency of the TB data and the SCA retrievals.
  - TB (global and site specific; climatology and 2rpm).
  - VSM retrievals

AMSR-E and AMSR-E

Regional TB inter-comparisons, Climatology

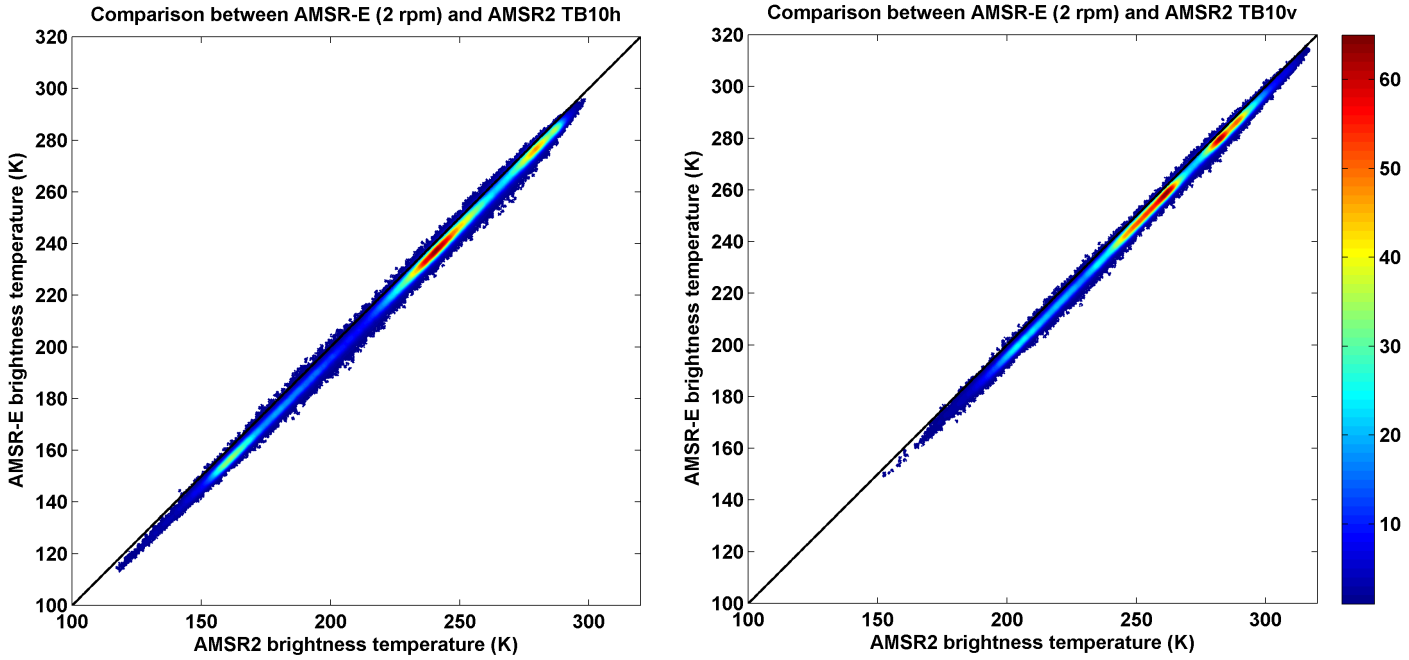


ARS Watershed Sites

Bias (relative to AMSR-E)

	H-pol		V-pol	
f	Asc	Desc	Asc	Desc
10.65	3.92	4.62	2.75	3.67
36.5	2.15	2.57	1.51	1.93

AMSR-E and AMSR2 TB
Global TB inter-comparisons, 2rpm



Global, Land

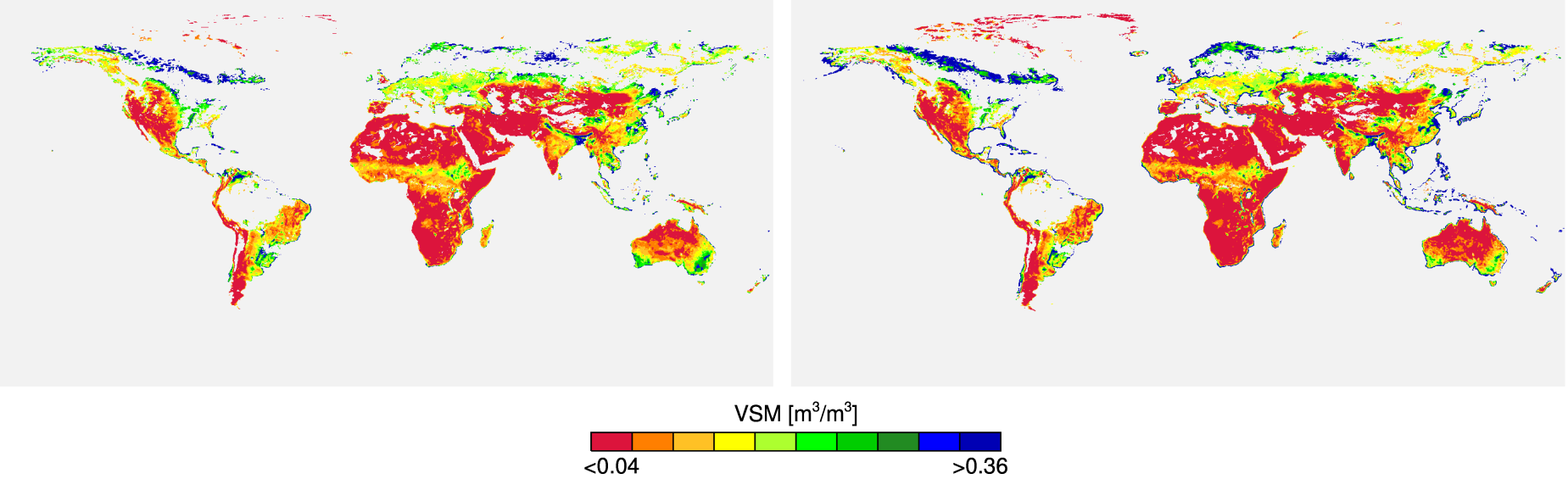
Bias (relative to AMSR-E)

f	H-pol	V-pol
10.65	3.67	3.20
36.5	3.13	3.17

AMSR-E and AMSR2
Global VSM inter-comparisons

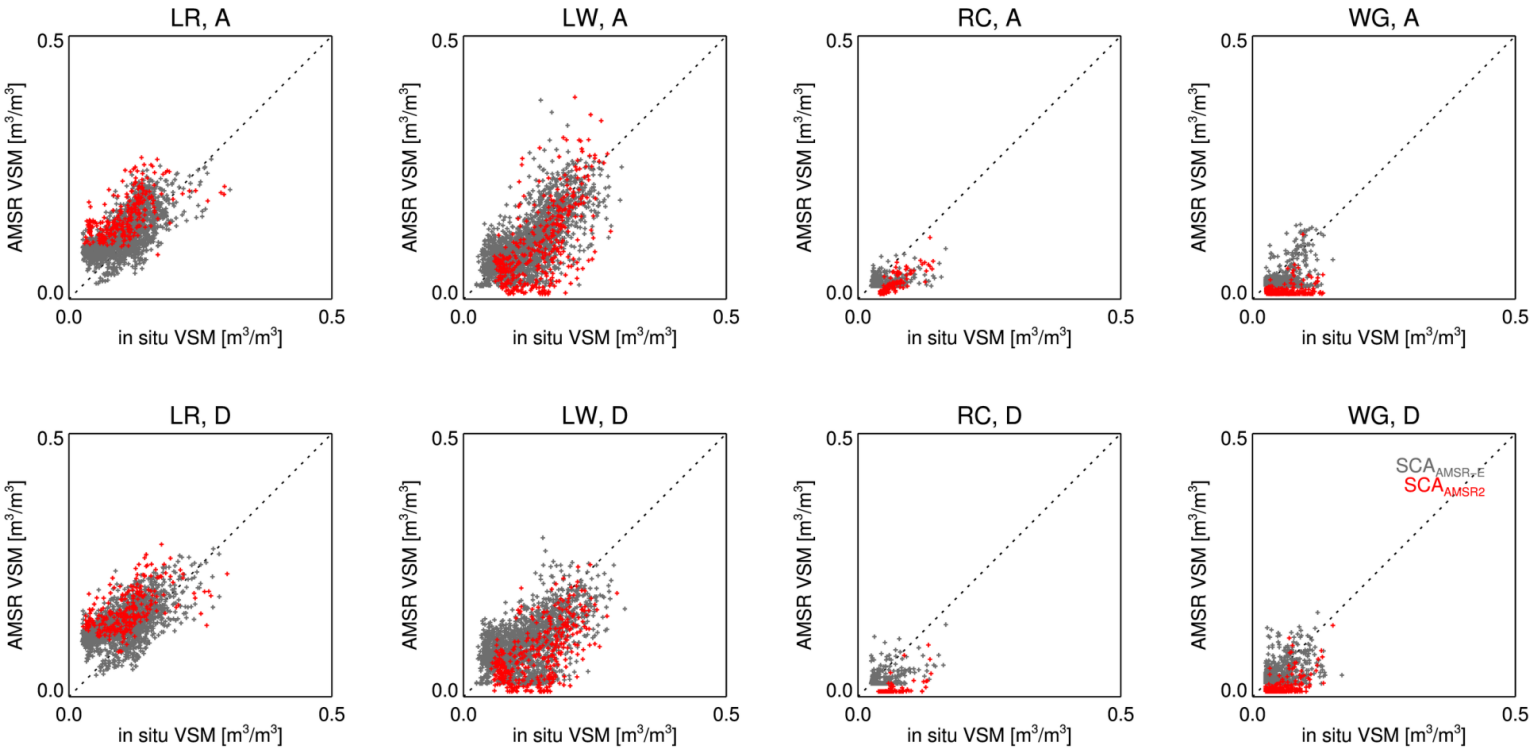
AMSR-E SCA VSM

AMSR2 SCA VSM



Global soil moisture maps. Data represent long term averages for the month of July. Maps show similar spatial structure and consistency between the two SCA retrievals.

AMSR-E and AMSR2
Regional VSM inter-comparisons



LR – Little River
LW – Little Washita
RC – Reynolds Creek
WG – Walnut Gulch
A – Ascending
D – Descending

		AMSR2	AMSR-E (*Jackson et al 2010*)
		SCA	SCA
Summary Performance	*R*	0.605	0.778
	RMSE	0.062	0.040
	Bias	-0.019	-0.002

Possible reasons for the observed difference:

Bias in the TB data;
Same algorithm version – AMSR2 and AMSR-E retrievals were generated using the same algorithm version.

SCA transferability to AMSR2: Summary

- AMSR-E and AMSR2 TB
  - Some bias;
  - Difference is consistent (.. sites and against the 2 rpm observations).

- AMSR-E and AMSR2 VSM
  - SCA was successfully implemented with AMSR2;
  - Pending more extensive validation.
  - Bias in TB has to be accounted for (several possible approaches);
  - Generating a consistent long-term soil moisture data record using data from AMSR-E and AMSR2: do we rescale the final retrievals or the TB?

Concluding Remarks

All

Schedule, Issues, Outlook
(Discussion)

- Where we are with respect to schedule
- Outstanding issues
  - AMSR-E
  - AMSR-2
  - LANCE
- Coordination with US AMSR team for overall AMSR-2 geophysical processing
  - Ancillary data
  - Common code for flag generation
  - Comparisons with JAXA products
  - Intercomparisons between AMSR-2, SMAP, SMOS, and other soil moisture products (SMAP task group)